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Transformation of Provider and Customer Organisations to achieve Co-capability in Outcome-based Contracts: A Viable Service Systems Approach

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About WMG Service Systems Group

The Service Systems research group at WMG works in collaboration with large organisations such as GlaxoSmithKline, Rolls-Royce, BAE Systems, IBM, Ministry of Defence as well as with SMEs researching into value constellations, new business models and value-creating service systems of people, product, service and technology.

The group conducts research that is capable of solving real problems in practice (ie. how and what do do), while also understanding theoretical abstractions from research (ie. why) so that the knowledge results in high-level publications necessary for its transfer across sector and industry. This approach ensures that the knowledge we create is relevant, impactful and grounded in research.

In particular, we pursue the knowledge of service systems for value co-creation that is replicable, scalable and transferable so that we can address some of the most difficult challenges faced by businesses, markets and society.

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The group currently conducts research under six broad themes:

- Contextualisation
- Dematerialisation
- Service Design
- Value and Business Models
- Visualisation
- Viable Service Systems and Transformation

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Transformation of Provider and Customer Organisations to achieve Co-capability in Outcome-based Contracts: A Viable Service Systems Approach

Abstract

This paper reports on research investigating organisational transformation of equipment-based providers and customers which are establishing joint capabilities to achieve combined equipment and service outcomes based upon outcome-based contracts. A viable systems approach provides the theoretical ground for investigating the systemic viability of both the provider and the customer to co-create activities to achieve equipment performance. The systems perspective of analysis required due consideration of the relationships between the functional parts of the outcome-based contract system, which led to the identification of key relationships between the firm and the customer that play an important role in preserving the viability of the system. The research findings suggest that contextual variety threatens the stability of the system and challenges co-creation. The findings also suggest that intervening in the customer-controlled supra-system to ensure its structural and systemic stability reduces variety for the system-in-focus. Assisting the customer organisation to transform also implies the provider's participation in supra-system activities.

Keywords: outcome-based contracts; co-capability; complex services; viable service systems

Introduction

To remain competitive, manufacturing organisations have increasingly felt the need to provide uninterrupted availability of their equipment through services such as repair, maintenance and overhaul (Baines et al. 2007; Caldwell and Howard 2011; Neely, McFarlane, and Visnjic 2011). In a manufacturing context, adding value to core corporate offerings through services is commonly referred to as servitisation (Vandermerwe and Rada 1988). While much of servitisation literature has focused on the transformation of the provider organisation to achieve good service outcomes, there is considerably less research on the effect on customer organisations that are using the equipment. This paper focuses upon the investigation of outcome-based contract initiatives, where the closely-coupled relationship between the customer and the provider to achieve service outcomes is crucial (Ng, Ding, and Yip 2013). We argue that a systemic approach is required when the provision of service is through outcome-based equipment contracts.

Traditional equipment-based service contracts are anchored on billable time and materials, with the cost of spare parts sometimes included in the maintenance, repair or overhaul of equipment, and the customer is billed for the service once the activities have been performed (van Weele 2002). Alternatively, the firm could provide the customer with a cost-plus contract with detailed cost structures to ascertain reimbursement with a pre-determined profit percentage (Kim, Cohen, and

Netessine 2007). Performance of such contracts are typically assessed based on response time to breakdowns, speed of repairs, price (Crocker and Masten 1991) and other activities where there is a measurable way to assess the provider's performance (Dehoog 1990).

Of late, there have been a growing number of contracts focusing on outcomes of equipment rather than on the activities involved in its service provision. For example, some of Rolls-Royce's service contracts to maintain engines are paid on the basis of how many hours the engine is in the air – a concept known as 'Power-by-the-Hour®'. Such outcome-based contracts focus on achieving required outcomes rather than meeting a set of prescribed service levels (Bramwell 2003). We argue that such a fundamental change to the value proposition of the service provider constitutes a major change in the configuration of the service system, necessitating a systemic approach towards transformation. This is because achieving outcomes in the customer space places a requirement on the provider to have much closer cooperation and coordination with the customer, resulting in more tightly coupled linkages between them. Academic literature in systems theory proposes that when systems become more tightly coupled, any interventions have to be particularly sensitive to 'unintended consequences'. For example, a recent Ministry of Defence (MoD) outcome-based contract was focused on three main availability outcomes: fleet 'Bank of Hours', 'Spares to Forward', and 'Tech Advice to Forward'. To improve availability and because MoD storage was effectively a 'free good', i.e. the costs were borne by the customer, the provider became unwilling to dispose of any spares. The unintended consequence of a change of contract was an increase in inventory, which directly contradicted policy decision to reduce inventory (see DE&S 2013; UK Parliament 2013).

When service outcomes are contractual, it becomes important that the integrated provider/customer system is stable, so that viability can be achieved. This has echoes with the viable service systems literature, where it is recognised that a system's viability is determined by its capability, over time, to develop harmonic behaviour in sub-systems and supra-systems through consonant and resonant relationships (Barile and Polese 2010a; Golinelli 2010; Pels et al. 2013).

This paper extends knowledge in servitisation and outcome-based contracts by taking a viable systems approach towards organisational transformation. We propose that the unit of analysis is the integrated system of provider and customer interactions and relationships, rather than simply that of just the provider or the customer. In taking this integrated provider/customer perspective, we map the systems concept of stability, variety, homeostasis, inputs, and feedback loops onto the interactions and relationships within outcome-based contracts. By so doing, our study provides insights into the interaction mechanisms through which the harmonic behaviour of sub-systems and supra-systems involving provider and customer organisations can be achieved. A typology of key relationships is developed and their roles in the process of variety absorption and attenuation are presented. The research findings suggest that intervening in the customer-controlled supra-system to ensure its structural and systemic stability reduces variability in the system-in-focus. Assisting the customer organisation to build competency also implies the provider's participation in supra-system activities. Our research proposes that a systemic transformation of the customer/provider relationships could achieve greater viability and stability for long-term equipment outcomes.

The paper is organised as follows. We first review the literature on servitisation, outcome-based contracts (hereafter OBCs) and viable systems to draw out the theoretical underpinnings of the study. This is followed by the presentation of the research methodology. Following on, we use the research findings to specify a systems model of the OBC context studied and to define a typology of critical relationships to counteract variety in the system. We conclude the paper by pointing out key aspects of the study and related issues for future research.

Theoretical Background

Servitisation and Outcome-based Contracts

Servitisation literature suggest that Product-Service-Systems (PSS) falls into three categories i.e. (a) product-oriented services, where the ownership of a "material product" is transferred to the customer and a service arrangement is provided to ensure it is well maintained; (b) use-oriented services, where ownership of the "material product" is often retained by the provider who sells and delivers the "function" of the product to the customer, such as leasing of office equipment; and (c) result-oriented services, where the service provider sells "results" and "outcomes" and may depend on several types of configuration in both equipment and services. For example, a 24-hour guarantee of 'event-free' for a security service may be a different configuration of surveillance cameras or security guards; under outcome- or result-oriented PSS, there may be no-predetermined product involved (Brezet et al. 2001; Cook, Bhamra, and Lemon 2006; Zaring et al. 2001).

OBC is a "*contracting mechanism that allows the customer to pay only when the firm has delivered outcomes, rather than merely activities and tasks*" (Ng, Maull, and Yip 2009, 377). The outcomes could be specified very broadly in terms of results i.e. outcomes *resulting from* use, such as paying for every day that is incident-free in the security of a building, or outcomes could be specified *in terms of* use, such as a bank of flying hours of a plane.

Most literature suggest that the transition from pure transfer of ownership of a product to an outcome-based 'servitised' product can be viewed as a linear continuum from a product space to a solutions space. For example Tukker (2004), in his widely referenced article, expands on the three categories of PSS models by presenting eight sub-categories of PSS within the spectrum of pure product to pure service (see Figure 1).

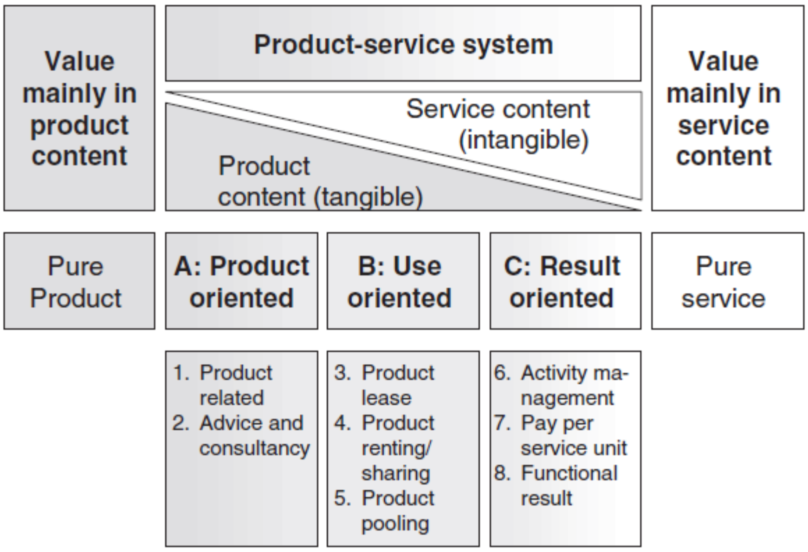


Figure 1 – Main and sub-categories of PSS (Tukker 2004, 248).

On one end is a high component of physical materiality and on the other, a high component of less tangible service activities. This suggests a mindset that deals with servitised product as some linear progression where ‘service’ resources to achieve outcomes is progressively ‘added’. Indeed, some literature consider OBCs to be synonymous with solutions-based contracts, where the provider provides a solution as an outcome. We consider that this mindset is highly reductionistic in nature in assuming that the aggregation of steps makes the 'whole'. What this view fails to take into account is the complex interactions that result from adding service components. For example, in the case of moving from selling surveillance cameras to offering 24-hour security, the provider will certainly want extremely low failure rates in the camera, probably more secure communication and to train security staff on how to monitor for suspicious activity. All of this requires a complete re-configuration of product design that will also include discussing with the customer the location of cameras and staff. We propose that OBCs are different from solutions due to three reasons.

First, a solutions orientation suggests that it is the provider that is responsible for the solution. In contrast, OBCs acknowledge that it is not possible to achieve an outcome without the customer co-creating or co-producing the service with the provider. This implies that there is a requirement placed on both the customer and provider to mutually align resources towards these outcomes (Kale, Dyer, and Singh 2002). This is a direct application of the value-in-use concept proposed by Vargo and Lusch (2008) under a service-dominant logic mindset, where customer usage is treated as an essential part of the OBC. In the context of OBCs, changing the focus from value capture to value co-creation entails the development of co-capability in provider and customer systems to yield the expected outcomes as opposed to solutions where only the provider is responsible (Ng and Nudurupati 2010).

Second, we also argue that a 'solutions' mindset results in the relegation of the customer to a passive role, which could result in lower engagement and a less meaningful experience. Literature has long suggested that engagement and involvement are key to customer satisfaction (Patterson, Johnson and Spreng 1996; Payne, Storbacka and Frow 2008; Bowden 2009). The logic of such an approach is that an engaged customer is a happy customer because it shows a provider that can respect and accommodate the customer's changing needs and is also able to manage the cooperation.

Finally, a ‘solutions’ mindset can result in cost inefficiencies. Since the provider has to deliver the ‘solution’ it would need to price its resources, and provider resources may not be cost efficient when the provision is at the customer location. For example, achieving outcomes of equipment in combat areas would be very expensive for private companies as bringing civilian resources into such areas would be prohibitively costly. In such cases, some of the resources could be provided by customer resources, not merely because access to these resources on site may be cheaper for the customer but because the customer has more relevant and appropriate information on when such resources may be required.

With solutions being provider-centric and in the provider’s control, and OBCs dependent on co-capability, servitisation from an OBC perspective would clearly be highly complex and therefore much more of a challenge. Tukker (2004) acknowledges this aspect by suggesting that as the provider’s offering rely less and less on the material product, complexity increases. The argument for an outcome-based view of servitisation, therefore, is that a systemic approach is necessary and the integrated customer/provider system should be considered not just to ensure outcomes, but to build co-capability.

The inclusion of customer resources for a provider to achieve outcomes would clearly create greater complexity, since customers resources are not within the provider’s control. Caldwell and Howard (2011) propose that when service is integrated with the product system, it is no longer merely ‘servitisation’ but a complex product service (CPS). They also suggest that CPS speaks to whole-life issues of complex projects including downstream services, which require co-creation with the customer. Similarly, Neely, McFarlane and Visnjic (2011) recognise value-in-use, co-creation of value and timescale as key features of complexity in PSS and add to the list product extension, capabilities, competition, networks and partnerships, financial flows, contracting, risk, the transformation journey, and technological complexity. They propose that the product-service transition makes the underlying operational delivery systems and processes more complex to manage and co-ordinate.

More recent studies in OBC have proposed that there is a need for understanding the different ways a firm is able to manage collaboration (Ng and Nudurupati 2010; Ng, Ding, and Yip 2013). More specifically, the theoretical aspects underpinning the dynamic firm-customer relationships in an OBC need to be studied, since the capability lies in the way a firm is able to achieve customer outcomes collaboratively.

Our study has the following research objectives:

1. To consider insights for OBCs from applying a systems approach, focusing specifically on
2. Consideration of insights for ‘transformation’ and ‘co-capability’ from applying a viable systems approach.

To address these objectives, we review the systems literature relevant to the OBC context.

Systems Approach

There are two important questions in systems thinking: what is a system and how does it behave? In addressing the first question, a simple definition is that a system is a set of components, elements or ‘parts’ within a boundary, which are in some ways more closely connected or coupled to each other than they are to the environment outside the boundary (Weinberg 2001). The essence of a systems approach is therefore on the relationships between the parts, rather than the parts themselves (Müller-Merbach 1994; Forrester 1968). A systems approach also implies an observer’s viewpoint in that this describes the boundary of the system (Weinberg 2001; Ulrich 1987) and in so doing makes a judgement concerning what is in the system and in the environment, and this also sets limits on the function and purpose of the system under analysis.

Central to a systems approach is the idea of a transformation. In an open system an input is transformed into an output, and feedback loops allow for control to be established. The relationships between the parts and how they are managed or controlled determine the behaviour of the system. The notion of control is extensively developed in the field of cybernetics and is the basis for Ashby’s (1956) law of requisite variety. The law is based on a simple model containing an external disturbance impacting on a regulated transformation leading to an outcome. For the outcome to remain successful, the variety of the regulator must be equal to the variety of the disturbance. This leads to the famous maxim “only variety can absorb, or destroy, variety”. Ashby’s (1956) work was later the basis for Beer’s (1984) Viable Systems Model and his models of an organisation as a ‘heart’ (Beer 1979) or ‘brain’ (Beer 1981).

The twin concepts of boundary and control are central to any discussion of systems thinking (see for example, Atkinson and Checkland’s (1988) review of systems concepts) and together they provide the structure for our consideration of servitisation and OBCs.

Viable Systems Model and OBCs

The collaboration between provider and customer and the establishment of ‘joint capabilities’ (co-capability) to achieve combined equipment and service outcomes is ultimately a function of the totality of the parts, rather than just the individual elements. In an OBC service system context, the totality of the parts is the boundary question, where the boundary is extended beyond the firm to include the customer. In order to understand how the system behaves, we use the theoretical framework of the Viable Systems Model (VSM).

VSM explicitly portrays operational, managerial and governance elements of a system and therefore provides a theoretical framework to analyse complex interactions across the operational, managerial and governance dimensions of OBC systems. Beer (1979, 1981, 1985) introduced the VSM and the principles of viable systems to describe the necessary conditions for viability, which is generally defined as the ability of a system to maintain its existence within a specific environment. We summarise here the key theoretical aspects of viable systems that underline the study.

A first aspect we recognise is that contextual variations coming from the external environment of a system, as well as the multitude of events that may arise within the system itself, confront the system with 'variety'. Contextual variety as described here is a measure of complexity, for it represents the number of different states in a system (Ashby 1956). Contextual variations may arise from changes in the external or internal environment, originating either from the provider or from the customer themselves (Palmetier 2008).

A second theoretical aspect considered in the study addresses the question: How do organisations cope with variety? The answer builds directly upon Ashby's (1956) law of requisite variety. As Beer (1984) puts it, managing variety is the very essence of management. A system has requisite variety when it has subsystems or mechanisms to attenuate and amplify variety so that variety in the disturbance can be met with variety in the regulator. More specifically, the viability of a system fundamentally depends on the ability of its parts to attenuate or amplify variety so that the system as a whole can absorb and generate as much variety as it receives. While attenuation decreases variety to the number of possible states a system can handle, amplification enhances variety to the number of possible states the system needs to remain fit to its environment (Holten and Rosenkranz 2011). Both attenuation and amplification can take place between a system and its external environment as well as between the internal subsystems of the system; for example, between operations and management or between management and governance subsystems.

A third aspect of particular relevance to the research refers to the constituent parts of a viable system as proposed by Beer (1984) or, more specifically, the VSM structure. This is a particularly useful theoretical basis to structure our analysis around operational, managerial and governance elements of OBC systems. More specifically, the VSM describes the necessary organisational structure for a system to survive in a constantly changing environment (Holten and Rosenkranz 2011). To be viable, an organisation should have five core components or systems necessary to ensure viability. These five systems are also related to fundamental functions within organisations, as summarised below:

- *System 1 – Operations*: It comprises the organisational units that carry out the operations activities. Each operational element is responsible for conducting specific operations activities within an organisation.
- *System 2 – Coordination*: It is the system responsible for creating stability and resolving conflicts between the operational units. It comprises important service functions such as finance, human resources and information systems for the operations in System 1, serving to restrain oscillations and disruptions that may occur between the units at operational level.
- *System 3 – Control*: It is the system responsible for optimisation, internal regulation, and generation of synergy between the operational units. System 3 supervises the operational activities of System 1 from a higher point of view of the total system, adjusting the allocation of resources to the operational units and regularly checking the use of the assigned resources through an audit channel termed System 3*, which informs System 3 about the state of affairs at the operational level.
- *System 4 – Planning*: It is the system responsible for defining strategies and long-term forward planning that lead to adaptation to future trends in the external environment.
- *System 5 – Policy*: It comprises the ultimate authority and ground rules for the system as a whole, establishing supreme values, policies and norms that apply to the whole system.

As shown in Figure 2, these core systems are connected via information channels that work as two-way communication loops of variety attenuators and amplifiers. Moreover, they recur within various instances of an organisation, comprising critical organisational functions. For example, some systems focus on operational activities and decisions concerned with the internal environment (the "inside and now"), other systems focus on strategic decisions and actions concerning long-term adaptation to the external environment (the "outside and then"), and others focus on normative decisions and actions concerning the governance of the system as a whole.

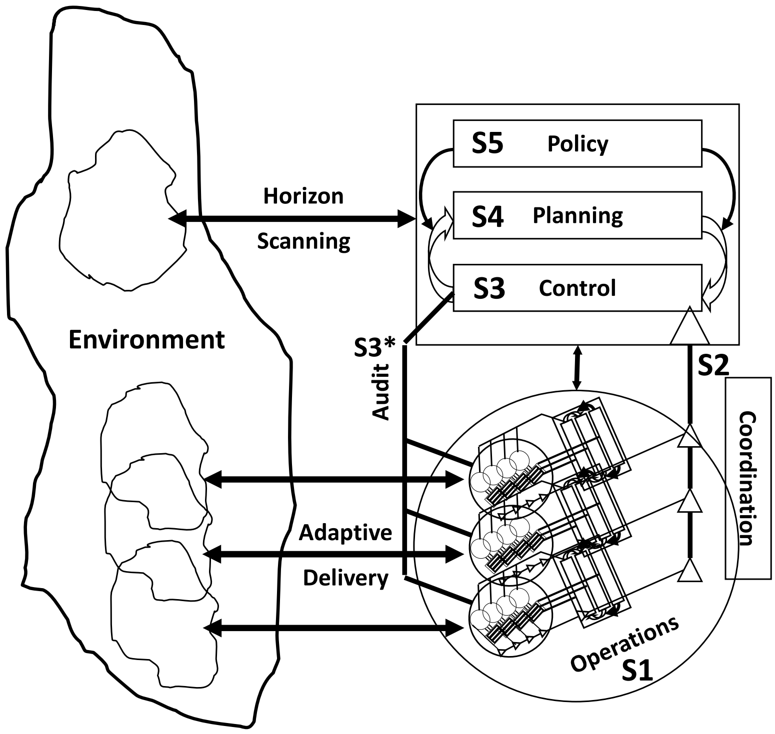


Figure 2 – The Viable Systems Model (VSM)

Barile and Polese (2010a) have considered the survival capacity of viable systems in a constantly changing environment. That is, a viable system has the capacity to dynamically adjust its structure and behaviour to achieve consonance with its context and thus preserve its stability. In essence this represents the homeostasis property of systems (von Bertalanffy 1968), which refers to a system's capability to adapt to external and internal disturbances (contextual variety) and restore its point of equilibrium in order to maintain stability and viability (Ashby 1956; Beer 1981). From a business perspective, homeostasis refers to a company's ability to maintain its state of equilibrium by counteracting internal and external turbulences through absorption of contextual variety (Ashby 1956; Ng et al. 2012). For instance, collaborative homeostats that ensure the continued viability of a system involve an organisation's ability to align its operations with its customer's environment as well as the organisation's ability to achieve stability in terms of managing the present with focus on the future.

Finally, a further theoretical aspect that the study takes into account is derived from the work of Barile and Polese (2010a, 2010b). According to them, the management of a viable firm requires transformation of static structural relationships into dynamic interactions with sub- and supra-systems. As they put it, "*the ability to organize relationships demonstrates top management efficiency and is a main characteristic of viable systems*" in business terms. This links with a particularly relevant aspect of OBC systems, i.e. in OBCs the dynamic interactions between the provider and the customer are crucial to guarantee that the resources the system as a whole needs to achieve the expected outcomes are properly integrated and allocated over time. In other words, the dynamic relationships between the firm and the customer guarantee the viability of the OBC system over time. From this relational perspective, the availability of resources can be achieved through the development of satisfactory relationships between the firm and its supra-system (Barile and Polese 2010a). To guarantee availability of resources in a viable system, the management has to reinforce the coordination and harmonisation of the relationships with relevant supra-systems in order to maximise the contributions made on behalf of both the provider and the other stakeholders (e.g. the customer). Additionally, these relationships enable consonant (i.e. compatibility between the actors of a system) and resonant (i.e. harmonic interactions between actors) behaviours that reinforce the viability of the system as a whole.

Ng, Ding and Yip (2013) recognise the critical importance of relationships in complex service systems by arguing that the building of co-capability in OBCs requires all stakeholders to invest in relational assets that are both value-driven and partnership-focused. Relational governance assets comprising inter-organisational exchanges complemented by social relationships are particularly significant for consolidating co-operation, reducing costs, and enabling flexibility to facilitate adaptation to environmental changes (i.e. counteract variety).

Context of the study

In the study, four major UK Ministry of Defence (MoD) OBCs were investigated. The contracts were intended to achieve defined outcomes in terms of availability of aircraft and related mission systems, and the aircraft engines. The contracts were awarded to two prime manufacturers of fast jet aircraft and engines in the military aviation and defence industry. Two of the contracts supported the UK's fleet of Tornado military aircraft and their engines, and the other two were for the UK's new Typhoon military aircraft fleet, which is set to gradually replace the Tornado fleet over the coming years.

Typical of OBCs, the service performance is rewarded on the basis of measurable outcomes in terms of the timely availability to the RAF (Royal Air Force) operator of aircraft (available flying hours) and engines, spares, trained maintenance personnel, and technical advice. Described by all parties as 'partnered support contracts', these involved a degree of co-location of customer and supplier at either the customer's or the supplier's premises, and were facilitated by the supplier's day-to-day use of "Government Furnished Assets" (jargon termed "GFx") including personnel, facilities, spares, services and data provided by the MoD customer. These OBCs operate under complex relationships between providers and customers, since the delivery of the contracts requires both parties (providers and customers) to focus on achieving outcomes. That is, the firm co-produces with the customer to achieve the outcomes.

Methodology

A case study approach is taken for this study, where qualitative research methods were used to derive insights into the service delivery of the contracts, including structures, processes, personnel and interactions involving the provider and the customer organisations. In conformity with qualitative research strategies (Bryman 2012), we employed a variety of techniques such as observation, analysis of texts and documents, interviews, and recording and transcribing to extract data for the purpose of understanding and analysis. The logic behind using multiple methods is to achieve an in-depth understanding of the dynamics arising from OBCs (the phenomenon in question) and related operational and managerial contexts. Furthermore, the fact that different parts of the large organisations involved in the contracts may also be at different stages of a transformation reinforced the need to adopt a qualitative approach in order to avoid the risk that participants' particular socio-institutional context may be lost where the collected data is quantified (Kaplan and Maxwell 2005).

Semi-structured interviews with 50 managers from provider and customer organisations were audio-recorded and subsequently transcribed, coded and categorised with the support of the software QSR NVivo 10. Inductive coding was used as the constant comparison analysis method (Leech and Onwuegbuzie 2007) applied to identify codes emerging from the entire dataset. This method is commonly used when a researcher is interested in utilising an entire dataset to identify underlying themes emerging from the data (Miles and Huberman 1994). Participant observation on service sites was also employed to document the interactions and relationships between provider and customer.

Applying the VSM Concept onto OBCs

The VSM provided the theoretical ground for investigation of the viability of interactive processes between key personnel, main activities, organisational structures and the systemic viability of both the provider and the customer to co-create activities to achieve equipment performance, as well as the transformation required by both provider and customer to achieve co-capability in terms of achieving contract performance.

Based upon underlying principles and building blocks of viable systems (Badinelli et al. 2012), the VSM helps to depict the structure of an organisation, its main operational and managerial components or systems, and the information and communication channels between the key components of a viable system (Beer 1981). In this respect, the VSM is essentially a useful framework for making organisational structures and links visible and comparable (Britton and Parker 1993).
We investigated both the system-in-focus and the two supra-systems (Golinelli 2010) of the OBC service systems under study. The system-in-focus is the provider's system of equipment provision and availability, and the supra-system (+1) is where the provider's equipment and various other resources are integrated within the customer's space for use in combination with customer's resources to achieve the expected outcomes. A further supra-system (+2) is the capability of the provider's equipment to achieve missions, i.e. the effect of the equipment. Examples of VSM diagrams for these two supra-systems in the OBC for the Tornado fleet are presented in Appendix I and II. The supra-systems are controlled by the customer at a recursion level above the provider's system-in-focus. Understanding the supra-system that is controlled by the customer therefore allows an understanding of the variety faced by the system-in-focus of the equipment service providers so that co-capability and transformation of both parties could be examined holistically.

Research Findings and Discussion

The initial examination of OBCs' origins and background in the subject context revealed that the MoD reached towards 'partnering' with its major industry suppliers as a contractual philosophy through intuition and an extension of practice and precedent rather than from any robust theoretical foundation. The logic was simply that traditional maintenance, repair and overhaul contract models were demonstrably wasteful and leading inexorably towards an unaffordable future. Moreover, at least for the Tornado, which has been in operation for a number of years, there would be a reliance on both customer manpower and equipment resources, i.e. GFx that was best managed jointly. Indeed, in terms of manpower, there were severe doubts that the industry could resource all of the necessary trained maintenance technicians from the local economy at a reasonable price.

From the perspective of OBCs, the high degree of contextual variety is represented by an increase in the heterogeneity of the contexts that deviate from the most likely contexts of use for which the service was originally designed. For instance, investigation of contextual variety of operational sub-systems showed that modern warfare is expeditionary in nature, requiring aircrafts to be deployed to locations where they and their supporting cast of aircrew and ground-crew may be put in harm's way. Also, fast jet aircrafts are complex engineering systems, densely packed with mechanical, electro-mechanical, electric, hydraulic, and electronic equipment that are required to operate at the top of their performance range in a far from benign environment in terms of temperature and vibration. As a consequence, they develop faults far more frequently than their civilian equivalents operated in far more sedate environments. Moreover, to ease the maintainability of so densely packed products, a philosophy of repair by replacement of "line replaceable items" (LRIs), i.e. items consisting of a cluster of parts that can be taken out when component parts are faulty, has evolved. This approach creates a modular boundary for changing systemic components that was a trade-off between what is efficient for the maintainer and effective, in terms of time, for the customer. This also resolved the tension between squadron operations and off-aircraft repair sites, and a potential cost resulting from 'information hiding' regarding the LRI's usage and its fault history. For example, it is not uncommon for an LRI to be removed from an aircraft only to be diagnosed as 'no fault found' when tested in the repair bay. It is not unreasonable for this LRI to be returned to service in this case, as it has been removed by mistake through erroneous front-line diagnosis. However, from a customer perspective, it would be unreasonable for the same LRI to cycle back and forth to the repair bay without some alternative intervention. A contractor paid a fixed amount per 'repair' may see it otherwise.

These findings confirm that contextual variety threatens the stability of the system and challenges co-creation for outcome achievement. This calls for a more in-depth analysis of operational elements and homeostatic processes developed to keep the viability of the system. We have applied the VSM to conduct such analysis, as discussed next.

VSM Analysis

Many previous studies have applied the VSM to analyse, describe, explain, and understand organisation structures and related structural relationships (Holten and Rosenkranz 2011; Jackson 2000; Kawalek and Wastell 1999; Vidgen 1998). In this study, we used the VSM to investigate functions, structures, and links (relationships) involving both the provider and the customer organisations in the OBC service systems examined. The model was used to depict the structural design and relational links involving the system-in-focus and related supra-systems at different recursive levels for the Tornado and the Typhoon OBCs.

Despite being different contracts, the general operational, managerial and governance structure for the Tornado and Typhoon contracts is similar. Thus, it is possible to describe the system configuration for both contracts analogously with basis on the classic VSM diagram, as shown in Figure 3.

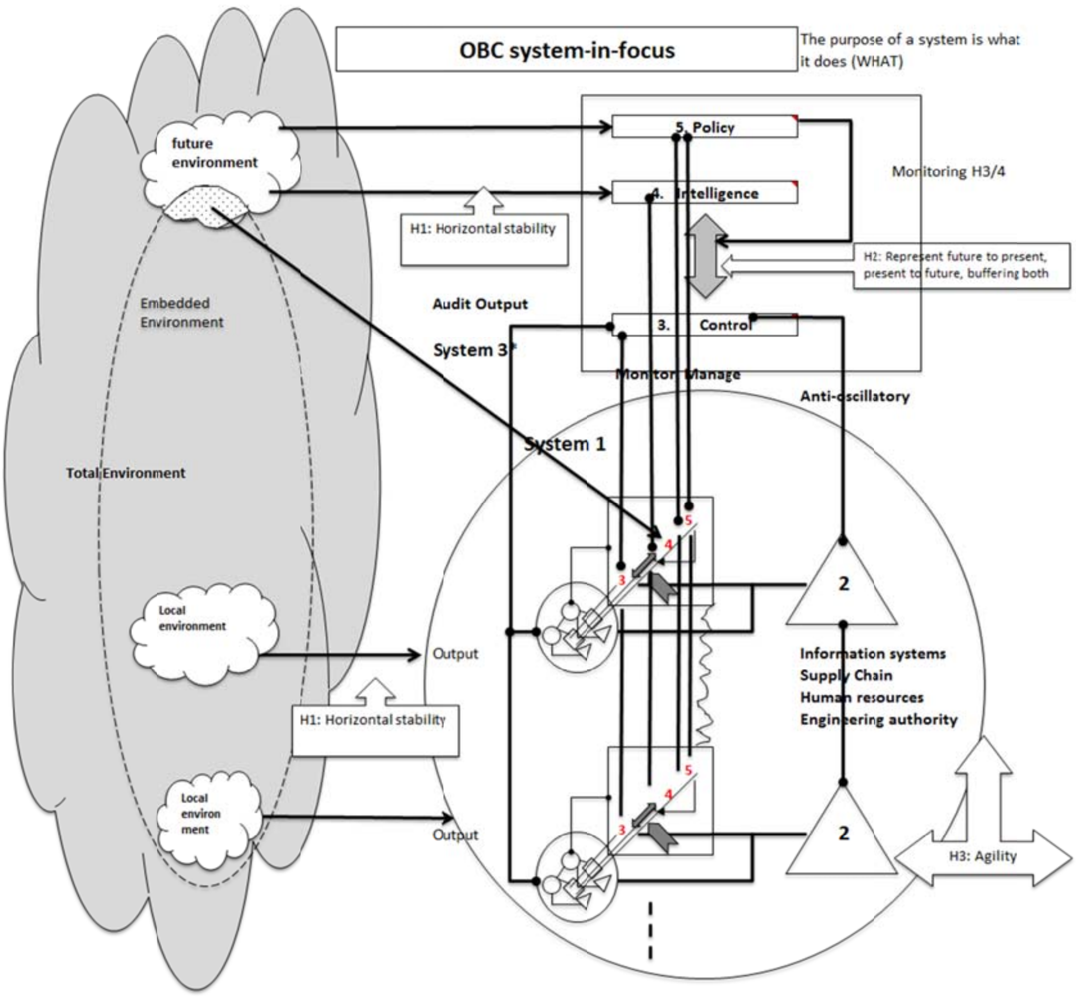


Figure 3 – The VSM for the system-in-focus of OBC contracts

In the model, System 1 contains the main operations that deliver the OBC outcomes. As Beer (1981) points out, System 1 comprises the operations that justify the existence of the system as a whole. It includes the management of the operations, but excludes senior management, which is comprised by other systems in the VSM. In the context of the OBCs studied, System 1 encompasses operations such as repairs and maintenance of aircrafts and related components to guarantee aircraft and mission systems availability, inventory management of part spares to ensure that they are available for repair activities and the operations do not suffer from shortages, transference of expert knowledge related to operation of avionics and mission systems devices, management of the capability of repair bays in order to ensure rapid turnaround of LRIs, and so forth. One respondent summarised System 1 operations as:

"*…in terms of repair solutions, they [involve] the engineers that drive these reliability improvement programs as we move forward... They're the, sort of, key areas, engineering, inventory and maintenance. So, that's really my value stream, effectively.*"

System 2 coordinates resources and processes between the various operations and recursions in System 1. It works as a regulatory centre for each of the System 1 components and it also comprises an overseeing regulatory centre at senior management level that links the internal coordination of System 1 operations with the control system in a higher instance (System 3). This gives System 2 the ability and authority to handle resolution of conflicts between the various activities taking place in System 1, toning down disruptions and ensuring that interactions are kept stable. In the OBC context studied, System 2 conducts relevant service functions for System 1, such as information systems and IT services, finance, human resources, engineering authority, and supply chain functions.

By its turn, System 3 has an executive function, supervising the coordination activities of System 2, as well as controlling and auditing resources and processes in System 1. It is the key controlling bridge between the activities of Systems 1 and 2 and the top management in Systems 4 and 5. The audit channel, which gives System 3 direct access to the state of affairs in the operational activities, is termed System 3* (Beer 1981). This allows System 3 to obtain more elaborated audit information by using System 3*, rather than relying on information provided by operational divisions only. By comprising activities such as accounting, production planning and control, operations planning, and audit rules, resources and rights, System 3 supervises all internal operational activities from a higher point of view of the total system. It leads resource bargaining and lobbying, which includes negotiation of resource allocation to the operations, and regular checking of the use of resources. This is illustrated by the comments below from a respondent in System 3:

"*…if we decide that we should spend less money on engineers and more money on supply chain people, for instance, we can make that choice and I'm the ultimate approver and authoriser that can move that money from one place to the next…I'm balancing cost and performance, so I'm the person who's actually, if you like, putting the brakes on for people who want to spend any amount of money to achieve any amount of performance. I'm the person saying no, no, no, we only need to provide 17 aircraft this month. There's no reason to provide 18, don't spend the money*".

System 4 is concerned with the external environment of the system-in-focus. It can be seen as the “external eye” of the system as whole, being responsible for monitoring the external environment, assessing threats and opportunities, and making plans to ensure that the system can adapt to a changing environment. It comprises strategy and marketing functions, which give System 4 the ability to scan the environment, forecast a future and plan for it. The close link with System 3 allows System 4 to have a clear view of the current state of affairs in the system and to plan its future state, including definition of future resources and development of new offerings. The intelligence processes in System 4 address eventualities, perspectives and responsibilities that are beyond the sight of managers in other systems.

Finally, System 5 applies established policy and ethos to ensure a balanced interaction between System 3 and 4 and that the system as a whole function within policy guidelines. More specifically, System 5’s main roles are to: (a) supply logical closure to the viable system; and (b) to monitor the System 3 and 4 ‘homeostat’. The former role effectively defines the identity and ethos of the organisation, i.e. its personality and purpose. The latter role seeks to maintain the balance between the management of “here-and-now” and the management of “out there and the future”. The strategic governance of the system as a whole sits within System 5, where board of directors’ activities take place. In the OBCs studied, the board comprised members from the MoD linked to the higher echelon of military institutions, and from the contractors linked to the higher echelons of their company.

When applying VSM as a basis for a structured analysis of OBC systems, we have observed a peculiar feature of OBCs concerning system boundaries. Since OBC outcomes can only be delivered with direct and active involvement and resource contribution of both the provider and the customer organisations, many of the activities from Systems 1 to 5 described above comprise resources and processes jointly provided and executed by the provider and the customer. Therefore, the VSM structure here discussed refers to OBC systems comprising provider and customer structures and relationships. That is, the VSM in the study represents a viable system of an OBC rather than a single organisation or institution. The model depicts a viable system comprising interlinking provider and customer systems whose boundaries overlap in order to deliver the expected OBC outcomes. In this sense, the classic systems' perspective of organisations whose system boundary separates what is inside from what is outside (Katz and Khan 1966), this way placing customer resources within an outside context, does not necessarily apply in an OBC situation where the boundaries of distinct organisations (provider and customer) entwine into a broader complex service system.

We have found that the fuzzy boundaries of provider and customer systems embraced by an OBC system jointly delivered by both organisations are a source of process ownership problems. As respondents put it:

- *"The [contract] doesn't have a strong tree, which is in a system perspective, that there is no ownership of the availability system."*
- *"…the ownership [of the system] is not at an enterprise level… at multiple levels there has been a dilution in terms of ownership and accountability."*

To deal with this problem, it is essentially important, particularly in OBC systems, to consider the notion of system purpose as observed by Forrester (1968) in his systems dynamics studies. According to him, a fundamental basis for identifying and organising a system structure is to have a proper and sharp definition of the purpose of the system. With basis on this premise, in OBC systems it makes more sense to visualise and specify many of the activities from System1 to System 4 around the purpose of the system and not necessarily with basis on organisational borderlines, which are intertwined in many circumstances. Placing customer resources as being in an outside system makes no sense in OBCs context, where GFx (Government Furnished resources) including personnel, facilities, spares, services and data are jointly managed by the provider and customer on a daily basis. In these situations the boundaries of the system-in-focus extend to include that of the customer and, as organisational boundaries become fuzzy, considering the scope of the system in terms of its overall purpose rather than its organisational borders holds together the many processes and resources from both organisations within a rational space.

By its turn, despite involving provider resources (i.e. top executives of contractors' higher echelons) System 5 is a governance system that predominantly consists of customer resources and processes. Thus, within the context of an OBC it seems appropriate to focus on the customer mainly when considering supra-systems. This reflects what was found during the research: the co-located provider and customer delivery teams were generally quite close-coupled, but their respective higher management echelons seemed less so. For this reason, the organisational boundaries are more visible in System 5 compared to the organisational boundaries of the other systems. Nonetheless, the purpose of the system is still a crucial aspect to be considered, as without a purpose it is impossible to define a system boundary (Richardson and Pugh 1981).

Another interesting aspect observed in the study is the high level of internal variety in the system not in terms of requisite variety implemented, but in terms of variety internally generated by the distinct systems (provider and customer) acting together in the OBC service system. This can be explained by the fact that OBC service systems typically have a substantial number of processes which are carried out jointly by the provider and the customer in different functions and recursive levels. As mentioned before, the ownership of such processes is in several circumstances unclear for the organisations involved and this is likely to be hindering consistency of resources across functions, convergence of assumptions and expectations, control and coordination of processes, and negotiation of priorities. Moreover, there is also performance variability in terms of the way the contract is measured (i.e. contract performance), as evidenced by the respondents' comments below:

- *"I think we have uncertainty in our contract, but we have a different way of dealing with it in as much as I would say 80 percent of the contract is well specified."*
- *"We do suffer quite a lot of disruption... sometimes the [contract] picture isn't particularly clear and sometimes it's very, very clear, but we do suffer from quite a lot of disruption but it comes from a variety of sources because we have multiple stakeholders."*
- *"We tend to get confused about the difference between contract and costs base."*
- *"…the contract doesn't stay the same, it's constantly being changed… so more and more things are coming into the contract and… so the baseline changes constantly as we move forward."*

As a consequence of this contract dynamics, many different KPIs (Key Performance Indicators) are applied to measure equipment availability, including spares delivered at different recursion levels involving different stakeholders. For instance, in terms of delivery of spares, the variability of KPIs is driven by the thousands of parts and related components in LRIs necessary to guarantee availability of aircraft fleet. The overall performance of the contract is therefore affected by this wide variety of components and units to be repaired or maintained at operational level. This contributes to an increase in the level of internal variety faced by both the provider and the customer. This aspect is evidenced by a number of managers who were interviewed in the study. We highlight below some of the anecdotal evidence that corroborate this potential problem in OBC systems:

- "*we've got too many processes… different layers of the organisation feel accountable for what we're doing here*"
- "*there's a demand for information pool from different layers of the organisation*"

- "*decisions are not rational… we have real issues and that's where a considerable amount of the disruption comes from*"
- "*I think we get the best information that's available, but there's so much uncertainty within government*"
- "*the way they're structured is not aligned to the advance in technology and it's not aligned to the world politics*"
- "*This level also creates the variety and the environment on which they need to operate. That's why it becomes very important for their* [the provider] *configuration to understand what's happening one recursion level up*"
- "*you'll have people that have very strong political or business views that will heavily influence the systems at different levels and in fact, possibly even, at all levels*"

Further analysis of individual agents and their interactions across managerial functions at different recursion levels of the OBC service system for Tornado and Typhoon revealed that to deal with the high level of internal variety in particular, as well as the variety coming from the external environment, managers from the provider and customer organisations interact on a regular basis through formal and informal relationships instances. These interactions proved to be an important mechanism to sustain the viability of the system as a whole. This interesting aspect of OBC systems is also a good example of how human resources are used to absorb the impact of variety in in the system, i.e. by monitoring and engaging with the customer on a regular basis the provider creates opportunities to attenuate internal contextual variety. Our study expands on this aspect by developing a typology of key relationships in OBC contexts, as discussed next.

Critical Relationships in OBC Systems

Mechanisms to deal with the law of requisite variety as well as the design of structural sub-systems and related communication channels are central to VSM applications (Vidgen 1998). The communication channels deal with internal variety between sub-systems in homeostatic loops aimed at balancing interactions. These interactions are inherently relationships between individual agents from different managerial functions and levels of the system. Most of the studies involving applications of the VSM tend to focus upon the identification of the sub-systems and little attention is paid to a more detailed identification of the relationships (i.e. the homeostatic loops) linking the different sub-systems.

Our research findings confirmed that OBC systems involve complex relationships between customers and service providers that rely heavily on tangible (equipment) and intangible (knowledge and experiences) resources as well as information-based relational assets to achieve the outcomes of the contract. The findings point out key relationships that fundamentally determine the performance of the contract, acting as mechanisms that allow the provider to intervene in the customer-controlled supra-system to ensure structural and systemic stability, therefore reducing variety not only in the system-in-focus, but also in the supra-system.

The key relationships identified in the study allow strategic and operational alignment between the firm and the customer systems in order to achieve OBC outcomes. More specifically, they can be seen as collaborative homeostats that ensure the continued viability of the system, counteracting variety by allowing the firm to align its tangible (e.g. material and manpower) and intangible (e.g. expertise) resources with complementary resources provided by the customer. In cybernetic terms, this alignment of resources represents attenuation and amplification processes that correspond to homeostat means to achieve stability in terms of managing operations to fit the present environment as well as managing the current state (the present) of the system with focus on the future.

Furthermore, the relationships identified seem to be an efficient way to guarantee availability of resources in the OBC system. They reinforce the coordination and harmonisation with the customer-controlled supra-system, maximising the contributions made on behalf of both the provider and the customer. They are practical examples of how a system can create consonant (creation of compatibility between provider and customer) and resonant (development of harmonic interactions between provider and customer) behaviours that sustain the viability of the system as a whole.

Through the coded data, we identified the critical relationships describe in Table 1. In general, these relationships influence the congruence of expectations between the parties involved, the consistency of resources allocated, their complementary competencies, the convergence of assumptions and expectations, the control and coordination of processes, and the negotiation of priorities. A detailed description of each relationship is provided in Table 1.

Table 1 – Critical Relationships in OBC Systems

Relationship type	Purpose

Check resource consistency	To check internally whether there is consistency in resources (e.g. manpower, budget, materials, etc.) that need to be available for yielding an expected outcome. This is important because in the military context of the OBC studied, customer personnel can be redeployed for different missions. Since outcome achievement is co-resourced (i.e. manpower from the customer is used), this relationship asset ensures that the necessary manpower was consistently available so that outcomes are not compromised.
Check assumptions	To ensure that the provider and the customer have the same assumptions about the future, the missions and the outcomes to be achieved.
Negotiate priorities	To establish clear priorities of actions. In times when resources may need to be redistributed, especially when mission capabilities require resource peaks and troughs, this relationship asset keeps the communication channel open so that priorities could be negotiated or renegotiated to lower the cost of resource use variety (e.g. peak time may require more resources which are costly).
Develop harmony	To set proper expectations, i.e. calm people down. This relationship asset tries to synchronise views and perspectives around specific outcomes to be achieved.
Lag control	To manage expectations concerning lead time. This relationship asset makes teams aware of the time necessary to deliver specific tasks and potential delays ahead.

Gather intelligence	To specify future implications and consequences of current actions and situations. It is also related to lag control because if you have more intelligence about delivery times, you can anticipate and lower the cost of lag.

It is important to mention that these relationships are mainly tacit initiatives developed through formal and social interactions between provider and customer members of staff at the management level, i.e. coordination (System 2), control (System 3), planning (System 4), and policy (System 5) levels. They represent homeostatic loops that enable organisational transformation towards co-capability, continuously shaping consonant (compatibility design) and resonant (dynamic adaptive delivery) behaviours in the system. As a manager in System 2 puts it:
"I've built strong relationships, obviously, in the maintenance world, in the inventory world and in the engineering world… those relationships are very important to me. They're working relationships that are being [developed] effectively… I already had relationships with these people, but what's happening now is, because of the value stream, we're going to look at co-location, which is a very important move, as far as I'm concerned, to get the integrated working that we need…"

Discussion

The identification of critical relationships in such complex service systems as OBCs is an important contribution of our study. More specifically, the study points out critical relationships through which attenuators and amplifiers can be continuously planned and designed, enabling co-capability and organisational flexibility for adaptive delivery of equipment availability in more cost-efficient ways. This links to Holten and Rosenkranz's (2011) argument that attenuators and amplifiers need to be designed. When they are not designed, they will occur because Ashby's law asserts itself (Beer 1981); however, in this case variety is balanced potentially at a greater cost. In addition, an interaction channel is not an attenuator or amplifier per se; what is necessary is the interaction between organisational agents who understand environmental situations and interact with each other to implement attenuators and amplifiers (Holten and Rosenkranz 2011).

Ultimately, the critical relationships identified in the study seem to be acting as practical mechanisms that allow the provider to engage with the customer-controlled supra-system, creating intervention opportunities for the firm and, this way, reducing the variety faced by the system-in-focus. Consequently the viability of the system as a whole is reinforced. In addition, the key relationships can also be seen as the means through which the provider can assist the customer organisation to adjust resources and materials necessary to achieve contract outcomes. Such systemic transformation involving key relationships aligned towards equipment use by customer and provider allows the achievement of greater viability and stability for long-term equipment outcomes.

The unique characteristics of OBC systems in the context of this study provide an excellent example of the complexities involved in organisational transformation in servitisation. The complexities of such service systems are mainly due to the substantial number of processes flowing across different functional areas requiring co-capability and co-allocation of tangible and intangible assets (e.g. materials, infra-structure, people, information and knowledge) from the provider and customer organisations in order to achieve the expected contractual outcomes in a sustainable (viable) way. Not uncommonly, the ownership of many processes in the system becomes unclear because of the complex configuration of the joint activities, interactions and structures involving the provider and the customer in several operational and managerial instances comprising the sub-systems of an OBC system.
This paper makes theoretical and practical contributions to the subject by providing a viable systems perspective and an initial typology of key relationships that are crucial to the building of co-capability in OBC systems.

From a theoretical perspective, the study depicts the complex structure of OBC systems in terms of a Viable Systems Model. This contributes towards a better understanding of the servitisation phenomenon through OBC initiatives by providing a graphical view of the operational, managerial and governance dimensions involved in an OBC system as well as the links between those dimensions. Such structured view allows the consideration of viability aspects necessary to make the system viable. For instance, the systems approach here applied requires due consideration of variety issues concerning OBC systems. The VSM analysis exposes the high level of internal variety faced by the partner organisations and reveals system boundary issues concerning the potential problem of process ownership in OBC systems.

Furthermore, the study provides a conceptual specification (typology) of key relationships developed to deal with the high level of internal variety in OBC systems, offering a theoretical basis for the planning and design of human activities aimed at developing co-capability. From a practical perspective, the more elaborated specification of key relationships developed in the study provides a useful reference for provider and customer organisations involved in OBC systems to develop vital interactions in a more purposeful fashion, rather than on an ad hoc basis. These relationships should not be merely aimed at building alliance to appropriate resources; they should also involve value co-creation activities towards outcomes and co-capability developments within the OBC system. As Ng, Ding and Yip (2013) put it, the capability to manage OBCs through different types of collaborations can potentially lead to OBC being an “enduring and viable alternative for equipment manufacturers and customers in achieving long-term use of equipment rather than continuing on the path of producing, consuming and discarding equipment”.

Conclusion

The understanding of OBC phenomena from a viable systems perspective is important for both researchers and practitioners interested in the viability agenda of complex service systems, contributing to the development of the increasing number of scholarly work on the matter and the challenges of achieving co-capability. The methodology and outcomes of the study provide insightful basis for the development of future research that could apply a similar approach. Although we cannot extrapolate the findings of this study beyond the business context of the case here, further research may be undertaken in other contexts and sectors.

Furthermore, the typology of key relationships specified in this study can be used as a reference for further research to examine the dynamics of firm-customer relationships in complex service systems (particularly OBC systems), refining this way the initial classification here developed and expanding on issues concerning co-capability coordination and alignment where the capability lies in the way a firm is able to achieve customer outcomes collaboratively.

Further studies could also consider the relational aspects here pointed out in relationships initiatives between firms with focus on trust development. The investment in value-driven relational initiatives can fundamentally determine co-capability and, ultimately, the performance of the system as a whole.

References

Ashby, W.R. 1956. *An Introduction to Cybernetics.* London: Chapman and Hall.

Atkinson, C., and P. Checkland. 1988. "Extending the Metaphor "System"." *Human Relations* 41(10): 709-724.

Baines, T.S., H. W. Lightfoot, S. Evans, A. Neely, R. Greenough, J. Peppard, R. Roy et al. 2007. "State-of-the-Art in Product-Service Systems." Proceedings of the Institution of Mechanical Engineers. *Part B: Journal of Engineering Manufacture* 221(10): 1543-1552.

Badinelli, R., S. Barile, I.C.L. Ng, F. Polese, M. Saviano, and P. di Nauta, P. 2012. "Viable Service Systems and Decision Making in Service Management." *Journal of Service Management* 23(4): 498-526.

Barile, S., and F. Polese. 2010a. "Smart Service Systems and Viable Service Systems: Applying Systems Theory to Service Science." *Service Science* 2(1/2): 21-40.

Barile, S., and F. Polese. 2010b. "Linking the Viable System and Many-To-Many Network Approaches to Service-Dominant Logic and Service Science." *International Journal of Quality and Service Sciences* 2(1): 23-42.

Beer, S. 1979. *The Heart of the Enterprise*. New York: Wiley.

Beer, S. 1981. *The Brain of the Firm – The Managerial Cybernetics of Organization*. 2nd ed. Chichester: Wiley.

Beer, S. 1984. "The Viable System Model: Its Provenance, Development, Methodology and Pathology." *The Journal of the Operational Research Society* 35(1): 7-25.

Beer, S. 1985. *Diagnosing the System for Organizations*. New York: Wiley.

Bowden, J. 2009. "The Process of Customer Engagement: A Conceptual Framework." *The Journal of Marketing Theory and Practice* 17(1): 63-74.

Bramwell, J. 2003. "What is Performance-based Building?" In *Performance-based Building: 1st International State-of-the-Art Report*, edited by A. Lee and P. Barrett, CIB Report 291. Rotterdam: CIB Publication.

Brezet, J.C., A.S. Bijma, J. Ehrenfeld, and S. Silvester. 2001. *The Design of Eco-Efficient Services - Method, tools and review of the case study based 'Designing Eco-Efficient Services' project*. Delft: Delft University of Technology.

Britton, G. A., and J. Parker. 1993. "An Explication of the Viable System Model for Project Management." *Systemic Practice and Action Research*, 6(1): 21-51.

Bryman, A. 2012. *Social Research Methods*. 4th ed. Oxford: Oxford University Press.

Caldwell, N., and M. Howard, eds. 2011. *Procuring Complex Performance: Studies of Innovation in Product Service Management*. New York: Routledge.

Cook, M.B., T.A. Bhamra, and M. Lemon. 2006. "The Transfer and Application of Product Service Systems: From Academia to UK Manufacturing Firms." *Journal of Cleaner Production* 14(17): 1455-1465.

Crocker, K.J., and S.E. Masten. 1991. "Pretia Ex Machina? Prices and Process in Long-Term Contracts." *Journal of Law and Economics* 43(1): 69-99.

DE&S. 2013. "Inventory management – the DE&S view", *desider – the magazine for defence equipment and support*, Ministry of Defence, April 2013, Issue 59, p.14.

Dehoog, R.H. 1990. "Competition, Negotiation, or Cooperation: Three Models for Service Contracting." *Administration and Society* 22(3): 317-340.

Forrester, J. 1968. *Principles of Systems*, 2nd ed. Waltham-MA: Pegasus Communications.

Golinelli, G.M. 2010. *Viable Systems Approach (VSA) - Governing Business Dynamics*. Padova: Kluwer Cedam.

Holten, R., and C. Rosenkranz. 2011. "Designing Viable Social Systems - The Role of Linguistic Communication for Self-Organization." *Kybernetes* 40(3/4): 559-580.

Jackson, M.C. 2000. *Systems Approaches to Management*. New York: Kluwer Academic/Plenum Publishers.

Kale, P., J. H. Dyer, and H. Singh. 2002. "Alliance Capability, Stock Market Response, and Long-term Alliance Success: The Role of the Alliance Function." *Strategic Management Journal* 23(8): 747-767.

Kaplan, B., and J. Maxwell. 2005. "Qualitative Research Methods for Evaluating Computer Information Systems." In *Evaluating the Organizational Impact of Healthcare Information Systems*, edited by J.G. Anderson and C. Aydin, 30-55. New York: Springer.

Katz, D., and R.L. Kahn. 1966. *The Social Psychology of Organizations.* New York: Wiley.

Kawalek, P. and D.G. Wastell. 1999. "A Case Study Evaluation of the Use of the Viable System Model in Information Systems Development." *Journal of Database Management* 10(4): 24-32.

Kim, S.H., M.A. Cohen, and S. Netessine. 2007. "Performance Contracting in After-Sales Service Supply Chains." *Management Science* 53(12): 1843-1858.

Leech, N., and A.J. Onwuegbuzie. 2007. "An Array of Qualitative Data Analysis Tools: A Call for Data Analysis Triangulation." *School Psychology Quarterly* 22(4): 557–584.

Miles, M. B., and M. A. Huberman. 1994. *Qualitative Data Analysis: An Expanded Sourcebook*, 2nd ed. California: Sage.

Müller-Merbach, H. 1994. “A System of Systems Approaches.” *Interfaces* 24(4):16-25.
Neely, A., D. McFarlane, and I. Visnjic. 2011. “Complex Service Systems – Identifying Drivers Characteristics and Success Factors.” Paper presented at the 18th European Operations Management Association (EurOMA) Conference, Cambridge, UK, July 3-6.
Ng, I.C.L., R. Maull, and N. Yip. 2009. “Outcome-Based Contracts as a Driver for Systems Thinking and Service-Dominant Logic in Service Science: Evidence From the Defence Industry.” *European Management Journal* 27(6): 377– 387.
Ng, I.C.L., and S. Nudurupati. 2010. “Outcome-based Service Contracts in the Defence Industry: Mitigating the Challenges.” *Journal of Service Management* 21(5): 656-674.
Ng, I.C.L., R. Badinelli, F. Polese, P. di Nauta, H. Löbler, and S. Halliday. 2012. “SD Logic Research Directions and Opportunities: The Perspective of Systems, Complexity and Engineering.” *Marketing Theory* 12(2): 213-217.
Ng, I.C.L., X. Ding, and N. Yip. 2013. “Outcome-Based Contracts as a New Business Model: The Role of Partnership and Value-Driven Relational Assets.” *Industrial Marketing Management*, in press, available online May 29, Elsevier.
Palmatier, R. 2008. “Interfirm Relational Drivers of Customer Value.” *Journal of Marketing* 72(4): 76–89.
Patterson, P., L. Johnson, and R. Spreng. 1996. “Modeling the Determinants of Customer Satisfaction for Business-to-Business Professional Services.” *Journal of the Academy of Marketing Science* 25(1): 4-17.
Payne, A., K. Storbacka, and P. Frow. 2008. “Managing the Co-creation of Value.” *Journal of the Academy of Marketing Science* 36(1): 83-96.
Pels, J., S. Barile, M. Saviano, and F. Polese. 2013. “VSA and SDL Contribution to Strategic Thinking in Emerging Economies.” Paper presented at the 2013 Naples Forum on Service, Ischia, Italy, June 18-21.
Richardson, G., and A. Pugh. 1981. *Introduction to System Dynamics Modeling with DYNAMO*, Cambridge-MA: MIT Press.
Tukker, A. 2004. Eight Types of Product–Service System: Eight Ways to Sustainability? Experiences from SusProNet. *Business Strategy and the Environment* 13(4): 246–260.
UK Parliament. 2013. “Ministry of Defence: Managing the defence inventory”, Public Accounts Committee, February 2013, Parliamentary Publications and Records. Accessed October 2013.
http://www.publications.parliament.uk/pa/cm201213/cmselect/cmpubacc/745/74504.htm
Ulrich, W. 1987. "Critical Heuristics of Social Systems Design." *European Journal of Operational Research* 31(3): 276–283.
Vandermerwe, S., and J. Rada. 1988. “Servitization of Business: Adding Value By Adding Services.” *European Management Journal* 6(4): 314–324.
Vargo, S. and R. Lusch. 2008. “Service-dominant Logic: Continuing the Evolution.” *Journal of the Academy of Marketing Science* 36(1): 1–10.
van Weele, A. 2002. *Purchasing and Supply Chain Management, Analysis, Planning and Practice*. 4th ed. London: Thomson Learning.

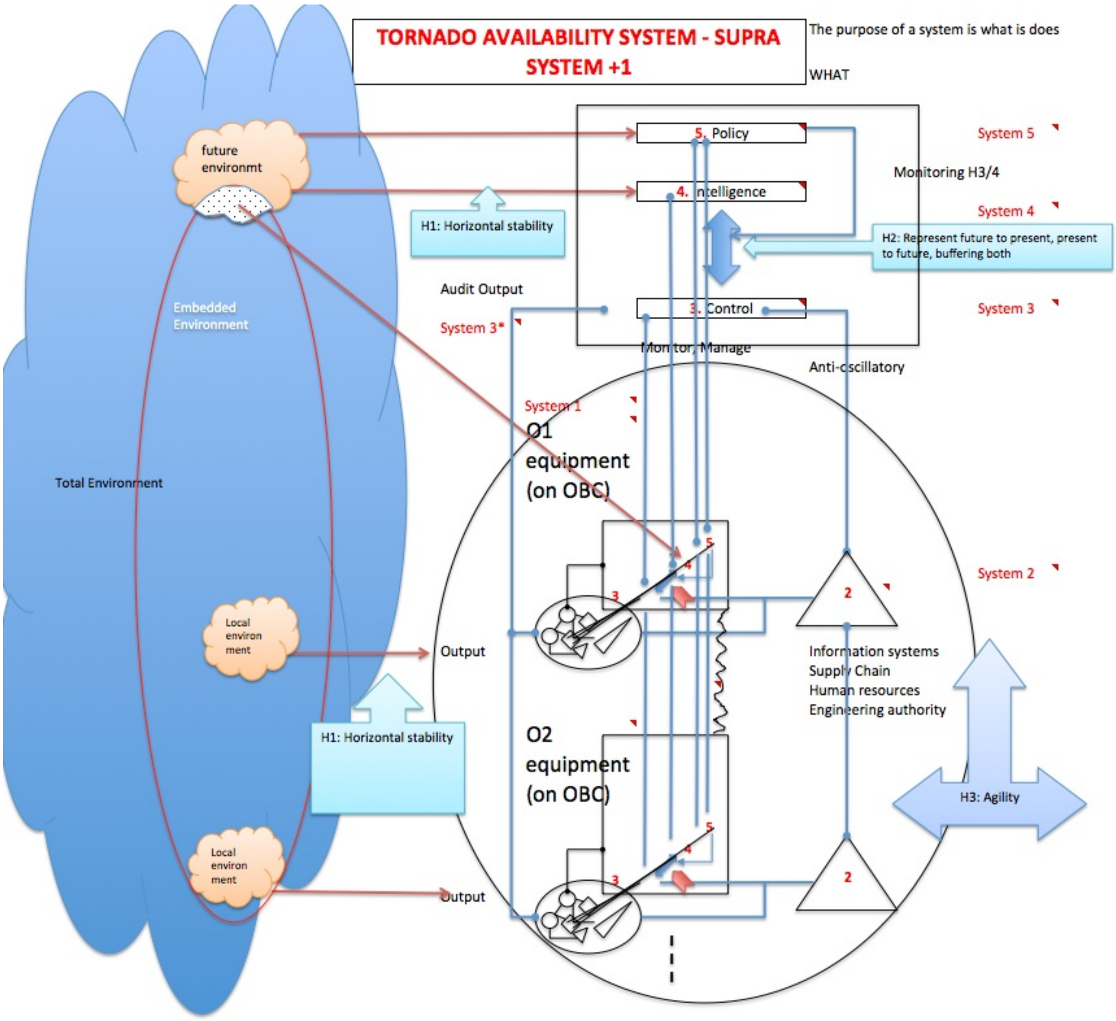
Vidgen, R. 1998. “Cybernetics and Business Processes: Using the Viable System Model to Develop an Enterprise Process Architecture.” *Knowledge and Process Management* 5(2): 118-31.

von Bertalanffy, L. 1968. *General System Theory*. New York: George Braziller.

Weinberg, G. 2001. *An Introduction to General Systems Thinking: Silver Anniversary Edition.* New York: Dorset House Publishing.

Zaring, O., M. Bartolomeo, P. Eder, P. Hopkinson, P. Groenewegen, P. James, P. de Jong et al. 2001. *Creating Eco-Efficient Producer Services*, Research Report. Gothenburg: Gothenburg Research Institute.

Appendix I: VSM of Supra-System +1 in the OBC for the Tornado fleet



Appendix II: VSM of Supra-System +2 in the OBC for the Tornado fleet